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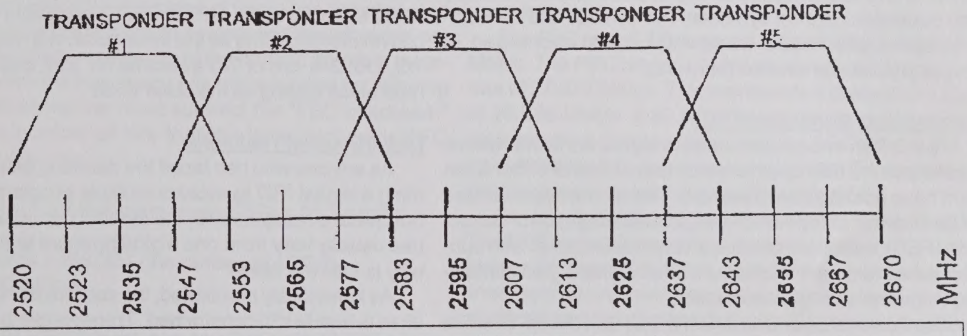
-INSIDE THIS ISSUE-

Reports from Jakarta that Indovision's S-band Cakrawarta satellite is now testing with limited service available. We try to avoid "news" reports here because of the long "shelf-life" of **Teck Notes**. Members have recently created tens of requests for assistance in tuning in the Indovision S-band transmissions. The latest - as of the date on this **Teck Notes** - is that Indovision is functional but the full extent of their coverage is unknown. Members are directed to page 31 of the July (1998) issue of SatFACTS for one version of their footprint coverage map we have sourced from Jakarta. What appears below is the channel (transponder) plan although we still do not know the polarisation details. For transponder centre frequencies, try 2436.6, 2565, 2595, 2625, and 2653.5 (MHz).

S-BAND DOWNLINK



SPACE Membership Teck Notes is compiled by SPACE Pacific to assist members in their own understanding of the ever changing technology in the fields of satellite communications and reception. Some material appearing here has been previously published outside of the Pacific + Asian regions and is made available to members for purposes of building a reference library. SPACE offers members the opportunity to advance their own formal training through the Mark Long SPACE Pacific "study at home" technical courses, each of which makes possible a certificate upon successful completion of a course of study (see pages 25/26, here).

Symbol Rates and FEC: A Programmer's Choice

by Mark Long (copyright 1998 MLE INC.)

Those of us who work in the digital DTH business frequently encounter esoteric numbers that we must plug into the digital set-top box before we can begin to receive any digitally compressed satellite TV service, or unified "bouquet" of services. Its easy enough to do without giving the matter much thought or having to understand just what the terms "symbol rate" and "FEC rate" actually mean. This article provides the answers for those who would like to fully comprehend the significance of these esoteric terms as well as understand why some programmers may select one set of numbers while others choose different operating parameters.

MPEG-2 Satellite Modulation Techniques

MPEG-2 satellite transmissions use a digital modulation technique known as QPSK (for Quadrature Phase Shift Keying). The production of QPSK modulation requires the simultaneous processing of two bits of information, whereby the data rate is effectively doubled without an increase in the signalling rate. This is an excellent modulation scheme for those transmission platforms that are bandwidth constrained.

A simple modulation system such as binary phase shift keying (BPSK) varies the carrier frequency between two distinct phase states to correspond to the binary digits 1 (on) and 0 (off). QPSK, however, uses four distinct phase states instead of two, which allows two bits to be transmitted simultaneously by switching between different combinations—called symbols—of the four available states. The digital encoder at the uplink converts bits in pairs (called "di-bits") into equivalent two-bit symbols. The symbol rate for compressed digital video transmissions is expressed in Megasymbols per second (Msym/s).

Forward Error Correction (FEC)

The QPSK-modulated satellite signal contains special codes that the IRD uses to check that all bits of information sent have actually been received. This forward (sent ahead to the receiver along with the original message) error correction (FEC) technique creates a very robust signal with substantial advantages over an uncoded digital signal containing the same information content.

The Forward Error Correction (FEC) "overhead" consists of redundant symbols that are added to the original message. Although this increases the overall transmission rate and bandwidth requirements, the redundant symbols accentuate the uniqueness of the message in a way that prevents channel noise from corrupting enough symbols to destroy its uniqueness. The decoder uses the FEC symbols to restore data reliability after the message has been received.

One type of FEC encoding, called the convolutional code, is expressed as a ratio such as 1/2, 2/3, 3/4, 5/6 and 7/8. The number in the numerator indicates the number of original symbols entering the encoder and the denominator indicates the number of error-corrected symbols leaving the encoder. Therefore, an FEC of 7/8 means that for every seven symbols entering the encoder, eight symbols leave; in other words, there will be one error-correcting symbol out of every 8 symbols.

The other type of FEC encoding, called the Reed-Solomon code, adds the redundant symbols to individual strings or blocks of binary digits. The encoder accomplishes this task by only looking at the symbols that comprise each discrete string or block of digital bits. Reed-Solomon uses 188 bytes out of every block of 204 bytes for transmitting the original signal information. The remainder is used to send parity bits that the IRD can use to correct transmission errors.

The Reed-Solomon decoder uses an algorithm to simultaneously solve a set of algebraic equations based on the syndrome of parity checks from the retrieved block. It is particularly good at detecting and correcting bit errors generated by burst noise that can be caused by automobile ignition noise or microwave ovens operating in the general vicinity of the receiver.

FEC systems that look at previously transmitted blocks as well as the current block, are called convolutional coding systems. The convolutional encoder has a buffer circuit that holds the previously coded messages in memory for reference. Convolutional coding is particularly effective in correcting or concealing thermal noise bit errors.

Early coding experiments found that an encoder that used two coding techniques in cascade (i.e., one feeding into the other) could generate additional performance gains. The first code is referred to as the inner code, while the second is called the outer code. MPEG-2 DVB-compliant systems use convolutional coding as the inner code, with coding rates of 1/2, 2/3, 3/4, 5/6 or 7/8 available for use, and Reed-Solomon block coding as the outer code.

Digital Bouquet Trade-offs

As anyone who has faced the daunting task of programming a digital IRD to receive multiple program services or bouquets already knows, the symbol rate and FEC rate in use usually vary from one digital bouquet to the next. Just why is that the case?

As I previously mentioned, the satellite transmission medium is bandwidth constrained. Transponder bandwidths of 27, 33, 36, 54 or 72 MHz are the typical choices available to programmers in various parts of the world. All digital transmissions must therefore conform to the bandwidth constraints of the transponder that each programmer elects to use to deliver digital DTH services.

The maximum possible symbol rate is a direct function of satellite transponder bandwidth. This can be calculated by the following formula:

Maximum Symbol rate = BW/1.2

Where BW = the bandwidth in Megahertz

Recommended MPEG-2 Service Data Rates

Video Services	Data Rate
High Definition Television (HDTV)	14.0 Mbit/s
Studio Quality CCIR 601	8.064 Mbit/s
16:9 Wide Screen Aspect Ratio	5.760 Mbit/s
Live Sports	4.608 Mbit/s
Film/Broadcast	3.456 Mbit/s
Pay Per View Movies	1.152 Mbit/s
Musicam Audio	
Monaural	128 kbit/s
Stereo	256 kbit/s
Stereo Pair	512 kbit/s
Digital Data	9.6 kbit/s
Service Control Data	30.72 kbit/s
Component ID Overhead (percentage of total bouquet data rate)	2 percent

For example, the maximum symbol rate for a 36-MHz wide transponder is:

36/1.2 = 30 Msym/s.

Suppose a programmer elects to use a 7/8 FEC rate. The bit rate for the digital multiplex, or bouquet, would then be:

30 Msym/s x 2 (2 bits per symbol) = 60 Mbit/s

The transport stream's maximum data rate may be 60 Mbit/s in this example, but some of these bits are allocated to the forward error correction system and therefore are not available for the transmission of the original program material. To determine how many bits are available for relaying the original signal, we must subtract the "FEC overhead:" that is, the number of bits that the inner and outer FEC codes actually use.

60 Mbit/s x 7/8 (the inner-code FEC) = 52.5 Mbit/s

52.5 Mbit/s x 188/204 (the outer-code FEC)
= 48.382 Mbit/s

From this example we can see that only 48.382 Mbit/s out of a digital bitstream running at 60 Mbit/s are actually carrying the original programming, conditional access data and bouquet component ID information. The next example alters the FEC rate from 7/8 to 1/2 while leaving all other parameters the same. Let's see how this change in the FEC rate for the inner code impacts the available bit rate for transmitting program information.

30 Msym/s x 2 (2 bits per symbol)
= 60 Mbit/s

60 Mbit/s x 1/2 (the inner code FEC) = 30 Mbit/s

30 Mbit/s x 188/204 (the outer code FEC)
= 27.647 Mbit/s

A unified MPEG-2 digital bit stream, or multiplex, may contain eight or more TV services with associated audio, auxiliary audio services, conditional access data and the bouquet's component ID information. Any single video signal within this bit stream will have a much lower bit rate and also will vary according to the nature of the video source material (see chart above).

The FEC rate of 7/8 supports a digital bitstream of 48.382 Mbit/s. The FEC rate of 1/2, however, will only support a bit rate of 27.647 Mbit/s. This represents a dramatic reduction of 20.735 Mbit/s. If all other transmission parameters remain equal, a programmer using an FEC rate of 7/8 can transmit at least four more entertainment TV services than another programmer using an FEC rate of 1/2.

So why don't all programmers use an FEC rate of 7/8? The FEC rate 1/2 generates a very robust signal that will better withstand rain fades and deliver a stable signal to small-aperture receiving systems with minimum signal margin above receiver threshold. Each programmer must therefore make a decision on transmission parameters that balances the desirability of having a robust signal against their need to transmit as many TV services as possible through a transponder.

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Digital Diagnostics, Part II

The Digital Video Broadcasting Standard

by Mark Long (copyright 1998 MLE INC.)

Most digital satellite TV broadcasters today are using a transmission system that conforms to parameters adopted by Europe's Digital Video Broadcasting (DVB) Group. The DVB standard, which was first published in January of 1995 by the European Telecommunication Standards Institute (ETSI), has since been adopted by numerous other broadcast entities around the world.

In 1994, MPEG-2 was adopted by the International Standards Organization as the worldwide standard for the compressed digital representation of video source materials. A commonly asked question is why do we need yet another standard when MPEG-2 was supposed to settle the issue once and for all? As the DVB Group likes to point out, MPEG-2 is not a single standard set in stone, but rather a flexible architecture consists of several "compression tool sets" that programmers can elect to use. What the DVB Group has done is select those MPEG-2 tools that best facilitate the the distribution of signals amongst different distribution platforms without requiring complex and costly decoding and recoding equipment.

DVB allows MPEG-2 digital signals to be seamlessly transported between various satellite (DVB-S), cable (DVB-C) terrestrial TV (DVB-T), SMATV (DVB-CS) and MMDS (DBV-MC or DVB-MS) distribution platforms without requiring any modification to the original transport stream. Satellite-delivered signals, for example, can be demodulated at cable head ends or terrestrial broadcast facilities and then seamlessly re-modulated for distribution. This dramatically streamlines the transferral process and results in economies of scale that would not have been realised if mutually incompatible MPEG-2 systems had won the day.

Delivering DVB Packets

The DVB encoder multiplexes all data into packets, with each packet containing a 1-byte header and a 187-byte message. The header contains a special code called the "packet identifier" or PID, which provides the instructions that the IRD needs to effectively process the message contained in each packet. For example, the IRD only needs to process those packets that contain the information pertaining to the service that the IRD is set to receive. All other packets in the digital transport stream can be ignored and discarded.

Four different package identifiers are commonly available. The VPID is the packet identifier for video data, while the APID is the packet identifier for audio data. The digital transport steam also must send a program clock reference (PCR PID) at intervals that the IRD uses to synchronise the VPID and APID packets. A data packet identifier (DPID) also is required to identify those packets that contain auxiliary data services, conditional access (CA) data, and the Service Information and Teletext data.

DVB Service Information and Teletext

One way that DVB has improved upon the architecture of MPEG-2 is through the introduction of a "Service Information and Teletext" (DVB-SI) component of the transport stream. This component includes each digital bouquet's satellite transmission frequencies, channel allocations and the modulation parameters.

The value of the DVB-SI is that it give each programmer the ability to reconfigure the digital IRD's software automatically from the uplink. The end result is that any changes made to the bouquet configuration are total transparent to the TV viewer. The digital IRD need only be set up once--usually pre-programmed at the factory--to find the first satellite transponder. After that, the IRD will be able to download all of the required transmission parameters, even if the programmer changes them from the original factory settings later on.

The DVB-SI component also sets the parameters for the transmission of an electronic program guide (EPG). The EPG can provide a wide variety of information, including service provider and channel name; programme name, type, and description; alternate channel programme lists; and forthcoming programme information.

The Program Association Table

The Service Information component contains a Program Association Table or PAT that provides each IRD with a list called a Program Map Table (PMT) that identifies every signal component within the MPEG-2 transport stream. An example of a PAT might look like the table presented below. From this PAT, the IRD can determine that the transport stream contains four video services and corresponding stereo audio pairs, as well as separate timing information for each service. The PMT also will provide the IRD with other information, such as the name and duration of each program service as well as any auxiliary data services that may be part of the digital bit stream. A Network Information Table (NIT) also is available that provides the IRD with a list the bouquet's associated transponders along with the transmission parameters for each transponder. In most instances, the associated transponders will be on the same satellite as the transponder to which the IRD is tuned. Some digital

Table 1. An example of a Program Association Table

PAT (PID 0000) = 0100, 0200, 0300, 0400

PMT 1 (PID 0100) = Video PID 0101, Audio PID 0102, Audio PID 0103) PCR 01FF

PMT 2 (PID 0200) = Video PID 0201, Audio PID 0202, Audio PID 0203) PCR 02FF

PMT 3 (PID 0300) = Video PID 0301, Audio PID 0302, Audio PID 0303) PCR 03FF

PMT 4 (PID 0400) = Video PID 0401, Audio PID 0402, Audio PID 0403) PCR 04FF

Table 2: DVB Cross-Platform Compatibility Table

DVB-S - A digital satellite broadcasting system for television, sound and data services that predominantly downlinks in the 11/12 GHz frequency spectrum. DVB-S includes specifications governing structure, channel coding and QPSK modulation at 2-bits per symbol. DVB-S also sets modem standards for variable transponder bandwidths and data rates so that each broadcaster can match their transmissions to the available transponder bandwidth. DVB-S also supports two forward error correction methods: an outer FEC using Reed-Solomon block coding [204, 188, T=8] and an inner FEC that uses convolutional coding, with 35% half-Nyquist filtering and rates of 1/2, 2/3, 3/4, 4/5, 5/6 or 7/8.

DVB-C - This is a cable broadcasting system for television, sound and data services using standard cable TV distribution frequencies. The DVB-C cable specification is based on DVB-S, but the modulation scheme is *Quadrature Amplitude Modulation* (QAM) rather than QPSK. DVB-C is centred on QAM modulation with 64 symbols (64-QAM). However, lower-level systems, such as 16-QAM and 32-QAM, as well as higher level systems such as 128-QAM and 256-QAM, also are available for use. DVB-C over an 8-MHz cable TV channel can accommodate a payload capacity of 38.5 Mbit/s if 64-QAM is used as the modulation scheme. The level of noise immunity varies as a trade off of system capacity against the robustness of the data.

DVB-T - Approved in February of 1997, DVB-T is a digital terrestrial broadcasting systems for television over standard broadcast TV frequencies. DVB-T uses a transmission scheme based on *Coded Orthogonal Frequency Division Multiplexing* that uses a large number of carriers to spread the information content of the signal. The main advantage of DVB-T is that it offers a very robust signal in a strong multipath environment. Due to the advantage of multipath immunity, an overlapping network of transmitting stations with overlapping coverage areas can operate on a single frequency.

DVB-T is designed to use either 1,705 (2k) or 6,817 carriers (8k). Each carrier system uses QAM modulation with 4 to 64 Symbols and 8 MHz of bandwidth. The 2k mode is applicable for single transmitter systems or relatively small single-frequency networks with limited transponder power. The 8k mode can also be used for single transmitter systems, but is more appropriate for large-area single frequency networks. Like DVB-S, DVB-T uses Reed-Solomon outer coding and convolutional inner coding for its FEC system.

DVB-CS - This is a specification for satellite master antenna television (SMATV) systems that distribute programming to households located in one or more adjacent buildings. A common satellite dish is used to receive the signals, which are combined with terrestrial TV channels and then sent to each household by means of a cable distribution system. In this case, the SMATV head end is totally transparent to the incoming digital multiplex, which is delivered to each IRD in the system without any baseband interfacing required.

DVB-MC - This specification is for use with a multipoint distribution system (MDS) using digital technology and microwave frequencies. DVB-MC is based on the DVB-C specification for cable TV systems and therefore can use the same set-top box that digital cable systems use.

DVB-MS - This is another specification for use with multipoint distribution systems. The DVB-MS specification, however, is based on the DVB-S specification for satellite TV systems and therefore can use the same digital IRD that digital DTH systems use. Instead of using a satellite dish, the IRD is equipped with a small MDS antenna and frequency converter.

DVB-SI - The specification for Service Information (SI) in digital video broadcasting systems.

DVB-CI - The Common Interface Specification for conditional access and other digital video broadcasting encryption applications.

DVB-TXT - A specification for conveying teletext in digital video broadcasting applications.

DTH systems, however, are equipped with a motorised antenna actuator that allows the IRD to receive signals from multiple satellites. In this case, the Network Information Table can supply the information that the IRD needs to locate associated transponders on other satellites.

The DVB-SI component also contains a Bouquet Association Table or BAT that provides each IRD with comprehensive information about the program resources that are contained within the MPEG-2 transport stream. For example, the BAT can identify programme content by category or theme. A separate Event Information Table (EIT) contains scheduling information as to when each program will air and for how long, while the Time and Date Table (TDT) provides the IRD with the correct time.

DVB Compatibility Issues

Various digital satellite TV broadcasters and manufacturers emblazon logos onto their IRDs which proudly proclaim that the units "DVB-compliant." Does this mean that we have finally entered a new era of global video compatibility? We wish.

Although the DVB Group adopted a common interface for conditional access (DVB-CI), the committee did not agree on any single encryption or conditional-access standard. Each digital IRD must have a compatible conditional access module and smart card before it can successfully receive any encrypted digital bouquet.

In some instances, national authorities have taken steps to ensure that all digital DTH programmers operating within their borders use the same conditional access system. In Spain, for example, the three leading bouquet operators all use the same conditional access system, which allows viewers to subscriber to any of the available services and use the same IRD to gain access, albeit with the assistance of as many as three smart cards. More often, however, there will be two or more mutually incompatible bouquets available within the same country or region, with each bouquet requiring its own proprietary IRD and smart card.

Does a DVB-compliant IRD offer superior performance over other types of digital set-top boxes? Don't bet the farm on it. The signal quality produced by any digital delivery system, whether DVB or something else, is largely a function of how many bits are assigned to any given transmission within the digital bit stream; what you receive can range from quasi VHS all the way up to HDTV. The quality of the video that each viewer receives is determined by the bitstream parameters that the broadcaster elects to use.

On the Road to High Definition Television

by Mark Long (copyright 1998 MLE INC.)

High Definition Television (HDTV) has long promised to enhance the quality of both the sound and the images to be displayed on our TV sets. Well hold onto your hats because HDTV may soon be on its way to a living room near you. Terrestrial and satellite HDTV transmissions will be capable of presenting more than twice the number of lines (1080) over what conventional TV pictures provide today. What's more, the video images will have the potential to deliver pictures with a sharpness that approaches, or even exceeds, the clarity of 35-millimeter film.

HDTV is just one component of a new digital TV (DTV) standard approved last year by the ITU. DTV also promises to eliminate the flaws inherent in the analogue-based PAL, NTSC and SECAM TV standards. For example, the new DTV standard for terrestrial broadcasting will accurately portray all the colors of the original image without viewers scrambling to adjust the tint controls on their old NTSC TV sets. New DTV sets also will employ sophisticated digital filtering and forward error correction techniques to detect and mask out noise, ghosting, and electrical interference from automobiles and electronic appliances. Video "crawl" and other analogue TV picture artifacts will also be a thing of the past.

DTV will offer broadcasters the option of delivering their signals in either the standard 4:3 aspect ratio used by today's TV sets or in a wide-screen, 16:9 aspect ratio that more faithfully reproduces the dimensions of film-based materials. DTV also will use digital audio transmission techniques to broadcast programs in stereo with surround sound.

A New Global Standard

On May 30, 1997, The International Telecommunication Union agreed on a new global standard for digital terrestrial television broadcasting (DTTB) that promises to deliver end-to-end digital TV with high-definition quality, and also unify television broadcasting systems worldwide. The ITU also unanimously agreed on the convergence toward a single HDTV production standard based on a High Definition Common Image Format (HD-CIF). This has given equipment manufacturers the go ahead to start delivering TV sets to anywhere in the world, thus providing economies of scale never available before, as well as worldwide portability for consumers and vendors.

DTTB represents the construction of a digital architecture that can simultaneously accommodate both high-definition television and conventional television services in the terrestrial broadcasting environment, while at the same time being interoperable with cable delivery, satellite broadcasting and recording media. The new Recommendation for High Definition Television programme production includes a new format, called the HD-CIF format, which is cited as the preferred format for new implementations. The HD-CIF format is characterized by using a single matrix of samples (1920 pixels by 1080 lines) irrespective of field and frame rate.

The ITU recommendation also unifies two 'competing' standards: the U.S. Advanced Television Standards Committee proposal and the European Digital Video Broadcasting proposal. Under the ITU Recommendation, the two systems will form a single compatible system that can be implemented on a global basis within the practical physical limitations of the current terrestrial TV channel assignment environment. Moreover, the new digital system will support multi-programme transmissions in existing channels through the use of digital video compression technology.

Analogue-based terrestrial TV systems leave adjacent TV channels unoccupied to prevent interference between TV stations operating within the same general broadcast area. It has been determined, however, that the new digital ATV services could occupy these unused channels without causing interference to existing analogue TV stations. The good news was that national telecommunication authorities will not need to assign any channel frequencies before introducing DTV services, thereby conserving scarce spectrum resources. What's more, total use of the frequency spectrums assigned for terrestrial TV broadcasting worldwide by finally be used in an efficient manner.

Under the ITU plan, existing analogue TV transmissions will eventually be phased out (within a ten year time-frame as proposed in the US, or within a longer time-frame as envisioned for Europe). As terrestrial TV transmissions change from analogue to digital, analogue TV sets will be fitted with set-top boxes to enable them to decode and process the new digital TV signals. Chips manufacturers have already announced that they were ready to start mass production of the chips required by the decoders to be integrated in the new TV sets. There are currently 1,288 million TV sets worldwide that eventually will need to be replaced. This is a huge market as well as a golden opportunity for those who work in the consumer electronics industry.

MPEG-2 Profiles, Levels and Layers

At the heart of the ITU's new DTTB recommendations is the MPEG-2 compression standard. MPEG-2 is actually a family of systems, with each system having an arranged degree of commonality and compatibility. MPEG-2 supports four different levels: High, High-1440, Main and Low Level. The design for each level, which is shown in the table presented on the following page, supports a variety of pixel arrays and frame rates.

The High and High-1440 Level can support high definition (HDTV) and advanced definition TV (ADTV) pictures with 1920 x 1080 and 960 x 576 pixel arrays, while the Main and Low Level can support standard TV pixel arrays of 720 x 576 or 352 x 288. All but one Level supports two spatial resolution layers, respectively called the Enhancement Layer and the Base Layer. All digital bitstreams and set-top boxes are also classified according to video frame rate, either 25 Hz or 30 Hz, depending on the accepted standard in each country of operation. Set-top boxes with dual frame rate capabilities are also possible. While digital bitstreams are set for one of the two frame rates, it also is possible for an MPEG-2 transport stream to carry programme material that is intended for more than one type of IRD.

Table 1. MPEG-2 Profiles Chart

> **Simple Profile** - The MPEG-2 profile with the fewest available tools.
> **Main Profile** - Contains all of the tools offered by the Simple Profile plus the ability to interpret B Frames for bi-directional prediction purposes.
> **SNR Scalable and Spatial Scalable Profiles** - Adds tools that allow the video data to be partitioned into a base layer and one or more enhancement layers, which can be used to improve video resolution or the video signal to noise ratio (SNR). The DVB standard does not support any of the SNR or Spatial Scalable Profiles offered in the MPEG-2 specification.
> **High Profile** - Contains all of the tools offered by the other Profiles plus the ability to code line-simultaneous colour-difference signals.

MPEG-2 also supports five different Profiles: Simple, Main, SNR Scalable, Spatial Scalable and High. Each profile consists of a collection of compression tools. For example, a Main Profile may use up to 720 pixels per line at Main Level, or up to 1920 pixels per line at High Level. Most 525 and 625-line broadcast TV signals use the main profile at the Main Level, while most future 1152-line HDTV signals or 960-line ADTV signals will use the High Profile at the High or High-1440 Level.MPEG-2 achieves a high level of flexibility by incorporating two spatial resolution layers for each of the available Levels and Profiles previously described. A single MPEG-2 transport stream can simultaneously deliver standard TV, as well as ADTV or HDTV signals in an economical fashion. This is accomplished by using the low resolution Base Layer to deliver a standard TV signal while at the same time using one or more Enhancement Layers to deliver the additional data required to produce higher resolution TV pictures. Together the enhancement and low-resolution layers deliver all the information that the HDTV set needs to produce a high-resolution picture. Standard TV sets receive the data they require exclusively from the Base Layer, while ignoring the data contained in the Enhancement Layer.

MPEG-2 transport streams that only use one layer are called non-scalable digital video bitstreams, while those supporting two or more layers are called scalable hierarchies. Those transport streams with scalable hierarchies offer the added benefit of having a more robust signal that is less prone to transmission path errors.

The U.S. Moves from ATV to DTV

The United States is serving as the test bed for the terrestrial rollout of digital TV technology. On December 24, 1996, the U.S. Federal Communication Commission (FCC) adopted a technical standard for what the Commission now calls digital television, or DTV for short. The new DTV standard has also been formally adopted in Canada, South Korea, and Taiwan and is actively being considered for adoption in Mexico, Argentina, Australia, Brazil, China, and Singapore, as well as by other countries throughout Central and South America, Australasia, and Asia.

DTV offers a multiplicity of digital TV, audio and data formats. These include the broadcast of one or two High Definition Television programs; five or more Standard Definition Television programs at a visual quality superior to an analog NTSC signal; numerous CD-quality audio signals; and the delivery of large amounts of data. The U.S. DTV standard does not require broadcasters to use specific scanning formats, aspect ratios and lines of resolution. Instead, the DTV standard offers each broadcaster a variety of options from which to choose.

Pixels and Lines

The U.S. DTV standard supports four fundamental arrays of vertical lines and horizontal picture elements or “pixels” that can be displayed on the TV screen: 480 x 640, 480 x 704, 720 x 1280, and 1080 x 1920. Although the NTSC standard is a 525-line system, only 483 of these lines are “active” lines, with the remaining “inactive” lines contained in the vertical blanking internal. Moreover, NTSC generates 756 pixels per line. Therefore the 480 x 704 and 480 x 640 DTV formats, which are roughly equivalent to NTSC in terms of vertical resolution, are also referred to as “STV” (for standard TV) formats. The 720 x 1280 array has been dubbed the “ADTV” (for advanced definition TV) format because its vertical and horizontal resolution exceed the performance char-

Table 2. DTV Standard Display Formats.

Digital Television Standard Display Formats

Vertical Lines	Horizontal Pixels	Aspect Ratio	Picture Rate Fields per sec.
480	640	4:3 4:3	60-I 60-P 30-P 24-P
480	704	16:9 4:3	60-I 60-P 30-P 24-P
720	1,280	16:9	60-P 30-P 24-P
1,080	1,920	16:9	60-I 30-P 24-P

I = Interlaced scanning   P = Progressive scanning

acteristics of NTSC, PAL and SECAM, while the 1080 x 1920 array is the "HDTV" (high definition television) format.

Field and Frame Rates

Field rates of 60, 30 and 24 fields per second are available. The 60 and 30 fields per second best accommodate video source material using interlace scanning, while the rate of 24 frames per second is advantageous for the transmission of all film-based source materials using progressive scanning. Media resources that use progressive scanning, such as film-based materials, differ from video resources using interlace scanning in that each line of an image is presented in sequence.

Video Compression System

DTV uses the MPEG-2 specification as the basis of its own compression system. DTV takes advantage of the layered structure of MPEG-2. One layer can transport an STV signal to less-expensive DTV sets, while at the same time additional layers can transport signal enhancements that will allow more expensive ADTV or HDTV sets to display higher-resolution images from the same digital TV broadcast. MPEG-2 data packets also provide for the transmission of virtually any combination of video, audio and data information. One major difference between an MPEG-2 DVB-compliant signal and a DTV signals is that the former uses a modified version of MUSICAM for the creation of CD-quality digital audio while DTV will use the 5.1 channel Dolby AC-3 surround sound system.

The Road Ahead

DTV manufacturers are now marketing digital set-top boxes that will permit a terrestrially transmitted DTV signal to be displayed by any analogue TV set. A variety of DTV sets also are appearing in the marketplace, offering the satellite service provider with an opportunity to sell and install DTV sets along with satellite receiving hardware. The new DTV sets featuring a 16:9 aspect ratio will also compel the digital DTH service providers to begin offering ADTV and HDTV broadcasts. The advanced capabilities of DTV will give terrestrial TV broadcasters and cable TV systems world-wide the opportunity to more effectively compete with digital DTH and digital cable TV service providers. The availability of the new DTV sets in the marketplace will also allow some high-power DBS operators to begin broadcasting movies in a high definition, wide-screen format as early as 1999.

The old Chinese curse "May you live in interesting times" in this case actually should be regarded as a blessing in disguise. The transition to digital television in the satellite, cable and terrestrial broadcast environments will provide all of us with new opportunities and greater freedom of choice as we enter the first decade of the new millennium.

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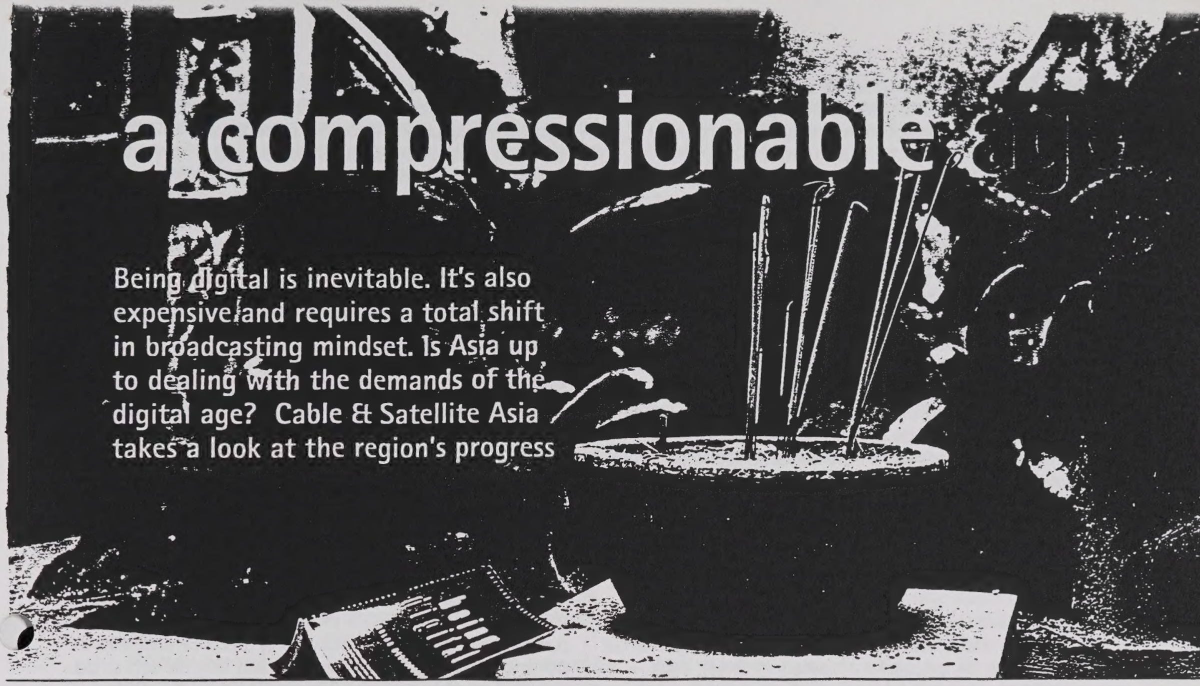
Note: Corrections, additions from members encouraged to maintain this list accuracy.



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Being digital is inevitable. It's also expensive and requires a total shift in broadcasting mindset. Is Asia up to dealing with the demands of the digital age? Cable & Satellite Asia takes a look at the region's progress

THE digitalisation of Asia was, in satellite terms, less a conversion from analogue than a leapfrog from zero to the latest technology. Yet there's still a huge questionmark over Asian consumers' ability to pay for all this high-priced, dollar-denominated technology. There is also the issue of Asian nations apparent inability to deal with the new business models demanded by a digital environment. While these are being sorted out, Asia stumbles forward.

According to the Discovery Asia's senior vice-president and general manager, Kevin-john McIntyre, most Asian countries are developing their delivery infrastructure as if "they were building the commercial infrastructure of a public utility." And therein lies the conflict — while regional delivery systems are among the world's most sophisticated and high-capacity, Asian governments want to control and limit what is delivered, including foreign television channels and the Internet. "This desire for control is a function of economic nationalism but is typically couched in the rhetoric of cultural imperialism, political stability and national sovereignty," McIntyre says.

In addition, he argues, Asian nations continue to use business models developed for analogue technology. Fearing loss of control, they are "very hesitant and reluctant to adopt the emerging and economically rational business models appropriate for digital distribution." Regardless of how technologically advanced they are, this limits Asian countries' ability to turn their media and entertainment industries into profitable enterprises.

"Asia needs to understand and appreciate the necessity of a global, or mass, cost structure and understand the inevitable consequence of digital technology on traditional media business models," McIntyre says. For example, individual countries in the region rarely offer a large enough consumer base to create a cable television channel for one market. McIntyre adds: "Ultimately, it is not often economically viable to create a pay-TV network in Asia for the niche channels in a digital multi-channel universe unless you are working with a global cost structure, or costs that are structured to be amortised over a very large, multi-country, mass consumer base."

There is no doubt that, with one or two exceptions, industry chiefs are a lot more aware of broad digital possibilities than governments are about recognising — much less dealing with — the issues involved. Star TV CEO, Gary Davey, says the advent of digital transmission has "revolutionised our industry. It is almost like we are starting over in defining what television can be... The creative and entrepreneurial skills of our industry are now under great pressure to take these fantastic new technologies and make them do something the consumer wants... and is prepared to pay for."

So far, Mr and Mrs Average Asian consumer have proved to be remarkably reluctant, not least because their buying power has been slashed in currency devaluations which have swept the region since July last year.

SATELLITE: Digital pay-TV roll-outs across the region have been less than stellar. The major markets which have gone digital — Thailand (IBC), Australia (Galaxy), Malaysia (Astro), and Indonesia (Indovision) — were, even before the currency crisis, well behind target. "The fact is that no market in Asia seems to have consumers who are happy to pay serious money for TV services," says John Lewis, business development manager for Pace Micro Technology Asia-Pacific.

Dramatic currency devaluation has exacerbated an already difficult situation. Programming and digital IRDs are traditionally paid for in US dollars (and usually heavily subsidised) by the platforms, while subscriptions are collected in local currency.

Existing digital services are expected to spend the next 12-18 months consolidating their ambitions. Most new services have been put on hold until 1999.

The digital trend in Asia appears to be towards a one-operator

market. "We believe that the set-up and initial costs of running a digital pay-TV service will mean that, ultimately, only one pay-TV operator will survive in each market," Lewis says.

CABLE: Although there is some interest from cable operators. No cable systems in Asia have taken up the digital option. Probably the closest anyone has come is Hong Kong Telecom, which launched a commercial video-on-demand system in mid-March. The system is fully digital, according to Hong Kong Telecom IMS managing director, Dr William Lo.

However, most satellite channels beamed to cable headends are digitally compressed. Broadcasters who have chosen this route include HBO Asia for its two channels, HBO and Cinemax, and the Discovery Channel (see chart). Star TV is also in the process of converting its 20-plus package to all-digital distribution. The switch should be complete by the end of the year. "My guess is that within two years, there will not be free-to-air [satellite television] anywhere in Asia," says Star TV chief executive, Gary Davey. In some cases the programming offered on the compressed services are country-customised. In many, however, digital compression is used primarily to service different advertising markets.

TERRESTRIAL: While the costs of digital terrestrial are a temporary barrier to entry in Asia, governments across the region are at various stages — ranging from nowhere to almost there — in working out spectrum issues, looking at digital terrestrial policies and investigating how to police this new delivery system.

In many countries, analysts say, commercial broadcasters appear surprisingly backward in gearing up to face a digital future. The warning has gone out: get up to speed or lose the advantage to more on-the-ball satellite players.

AUSTRALIA

The digital terrestrial television policy delivered in March required a delicate balancing act by the government. Faced with an upcoming election and rival media dynasties pushing in opposite directions, a compromise solution was inevitable.

With an eye on their US counterparts, the three commercial free-to-air networks wanted enough digital spectrum to broadcast one cinema-quality High Definition TV channel as well as the flexibility to offer up to six multi-channel services if HDTV does not take off in the US. Guided by the Packer family's powerful Nine Network, the network lobby asked for the loan of 7 MHz of adjacent spectrum to simulcast its analogue and digital channels for 15 years. The two public service broadcasters supported the networks, although they would need extra government funds to convert to digital.

Opposition to the network lobby was spearheaded by News Corporation, controlled by the rival Murdoch family, who saw a window of opportunity to re-enter the free-to-air business it was forced to vacate in the mid 1980s when Rupert Murdoch became an American. News wanted the government to auction off digital spectrum so it could buy into the network business, which would require changes to the current foreign and cross media ownership limits. As a 50 per cent partner in the Foxtel cable service, News Corp also had an interest in preventing the networks from offering competitive multi-channel subscription services.

Under the catchy title, the Coalition Against Digital Spectrum Giveaway, News Corp gathered a formidable group behind its call for more media diversity and competition. By the time the government made its decision, the Coalition included all the subscription operators; Telstra, the powerful telco which is News' partner in Foxtel; rival newspaper publishers such as Fairfax; and a swag of service companies, including Internet service providers eager to secure spectrum for delivering their information products to the TV set. News, a major publisher of classified newspaper advertising, was also interested in limiting the advantage the nets could secure in datacasting information alongside their digital TV programming. Packer's Nine, for instance, had already formed NineMSN, a joint venture with Microsoft, and the Seven Network had a interactive trial coming up with Intel.

The Government's compromise policy delivered something to everyone. As a spoiling strategy to stop the commercial nets winning everything they wanted, the News Corp-led Coalition had some success. The nets won their free digital spectrum, but only for eight years, when newcomers may be allowed, and they will be required to broadcast in a tightly-controlled environment fenced in with conditions and future reviews.

The conditions include use of the digital spectrum for only one HDTV channel; no multi-channel or subscription services, although 'enhancements' linked to programmes on analogue channels are permitted; digital broadcasting must start by 2001; and minimum levels of HDTV programming. The nets must also purchase any spectrum for datacasting at a price equivalent to the amount paid by other datacasters who won the right to bid for limited spectrum through an auction process.

Various inquiries, reviews, committees and working groups must still determine other key aspects of the policy, such as whether the publicly-owned ABC and SBS can offer multi-channel services; the choice of either the US or European digital transmission standard; regulations on the so-called enhancements; and compatibility requirements with present conditional access systems. Telstra, for instance, has chosen Scientific Atlanta's CA system for digital satellite and NDS for its analogue cable system, while Optus uses General Instrument for analogue cable and Irdeto for digital satellite.

Meanwhile, News Corp will have plenty of chances after the election to renew its lobbying on foreign and cross media limits. There is even an inquiry before digital terrestrial begins in 2001 on possible legislative changes triggered by the convergence of broadcasting and non-broadcasting services. *– Liz Fell*

HONG KONG

Hong Kong broadcasting authorities have committed themselves to a digital future — but have so far not revealed their road map or convinced anyone that they have one. Optimists hope the comprehensive broadcasting review in the middle of this year will reveal that local broadcast bosses have a grasp of just how important an overall digital policy is for taking Hong Kong into the next century. Cynics, however, say that the mindset responsible for mis-shaping Hong Kong's broadcasting past is probably not capable of looking clearly into the future. However, they acknowledge that Hong Kong's new Information Technology and Broadcasting Bureau (ITBB), which replaced the Department of Broadcasting, Culture and Sport earlier this year, has the opportunity and the telecoms broadcasting know-how to do the right thing.

Although details of broadcasters' submissions to the government on the TV review — including their recommendations on the migration to digital TV transmission — have not been

disclosed, various parties are believed to be pressuring the government to set a digital policy before making any other broadcasting decisions. This, they stress, is absolutely essential to avoid the ad hoc, piecemeal strategies of the old administration. At least one broadcaster has called for a joint industry digital TV committee to examine the issues involved in establishing a future-proof digital strategy.

So far, the government has not displayed any sense of urgency, even though the deadline is 15 months away. By mid-1999, the territory's two terrestrial broadcasters have to be told details of their new licence conditions. If they aren't, the government will have to wait until the terrestrial licensees' mid-term review in 2006 to put in place a digital strategy. This does not bode well for Hong Kong's positioning as a regional broadcast centre. However, most industry insiders will argue that the race was lost as long ago as the mid-1980s, when the then colonial government fiddled about not making up its mind about overall broadcasting policy.

Apart from Hong Kong Telecom's video-on-demand system, the closest Hong Kong has come to digital broadcasting so far is a joint venture between Star TV's original owner, Richard Li, and US computer chip manufacturer Intel Corp to launch interactive digital services across the Asia-Pacific. Li's company, Pacific Century, owns 60 per cent of the joint venture company, Pacific Convergence Corp. Intel holds 40 per cent.

Although not part of the DVB group, Hong Kong Telecom's interactive iTV service delivers a number of on-demand services in what it claims is the first fully-commercial VOD roll-out in the world. The 12-year VOD programming licence was issued in March this year, and by the end of April the platform claimed more than 32,000 subscribers with another 32,000 on the waiting list. – *Janine Stein*

INDONESIA

In Indonesia, Indovision has fewer than 30,000 subscribers to its digital platform, way fewer than the one million — or five percent penetration of 18 million TV households — original target. Costs in Rupiah have soared since the devaluation. Hardware and installation costs are now around Rp3.5 million (US$350), from pre-crisis levels of around Rp1.7 million (US$170 at current exchange rates). Monthly subscriptions range from Rp42,900 (US$4) for the basic 19-channel package to Rp108,900 (US$11) for the full service, which includes four pay-TV channels

While Pace previously had the Indonesian IRD market to itself, Thomson Consumer Electronics has recently come up with what it claims is an exclusive deal to supply 500,000 digital satellite decoders to PT Matahari Lintas Cakrawala, which operates the Indovision platform. The deal runs for four years from January 1998. The IRDs will be used for the new Indovision service off the Cakrawarta-1 (formerly Indostar) satellite's S-band transponders (see Digest story).

Various groups have flagged multi-media projects. However, their ability to launch new platforms into Indonesia's current economic environment is in serious doubt. – *Janine Stein*

JAPAN

Japanese broadcasters are gearing up for a complete switchover to digital, some with greater enthusiasm than others. The leaders are Japan's communications satellite (CS) TV platforms, which have been making the change since the launch of the PerfecTV digital DTH platform in November 1996. On May 1, PerfecTV (600,000 subscribers) merged with JSkyB to form SkyPerfecTV, which plans to increase its current 107 channels to 170 by year end beamed via two digital satellites.

Rival DirecTV, which began broadcasting in December 1997, aims to expand its channel line-up from 88 to 120 by end 1998. This means Japanese viewers will have access to nearly 300 digital CS services by beginning 1999.

Meanwhile, NHK's two satellite channels — the Wowow entertainment channel and the Hi-Vision channel — are still aboard the BS-3 analogue broadcast satellite. They plan to switch in 2000, with the launch of the BS-4 digital satellite. Japan's five commercial networks are all interested in broadcasting on the BS-4 and have formed subsidiaries to manage their BS stations. In addition to conventional broadcasts on as many as three channels, the new BS stations will offer HDTV and data broadcasts.

Terrestrial broadcasters have been less-than-eager to make the digital changeover. In March 1997, when the Ministry of Posts and Telecommunications announced that it intended to speed up the digital terrestrial debut from its previous deadline of 2007 to 2000, the terrestrial networks howled in protest, claiming the cost of digitalisation, estimated to be as high as Y1 trillion ($7.63 billion) for commercial broadcasters alone, was too steep, especially given expenditure of Y20 billion ($153 million) to Y30 billion ($229 million) each on their BS operations.

NHK president, Katsuji Ebisawa, says although digital terrestrial in Japan is inevitable, "it will be impossible for NHK to begin (terrestrial digital broadcasts) by the year 2000." He says NHK's first priority is the launch of its digital DTH service aboard the BS-4 satellite. "If we don't first establish the viability of digital BS broadcasting before we start terrestrial digital broadcasts, the technical and financial burden will be too much for us to bear."

The MPT has since backtracked on the 2000 deadline and is no longer insisting that all terrestrials go digital by the millennium. Even so, officials remain committed to pushing for an early transition, and have unveiled details of its digital roll-out schedule. According to the government timetable, NHK and the five Tokyo key stations will be the first to launch digital broadcasts, including multichannel and interactive data broadcasts. The conversion to digital is to be completed by 2006. The MPT will decide the exact date for the cessation of analogue broadcasts by 2001.

The work on technical standards for terrestrial digital broadcasting continues. In January, an advisory body of the MPT recommended five broadcasting standards for the digital DBS broadcasts, including the 720P standard being advocated by the Wintel group of the US computer industry. Japanese electronics makers and broadcasters will develop broadcasting equipment and receivers based on a selected standard, with winners and losers to be decided by the market.

The frequencies for digital broadcasts are expected to come from the UHF band.

Finally, the MPT will change its regulations to allow foreign companies and Japanese companies with programming software to freely link with broadcasters to operate digital broadcasting channels. MPT regulations currently restrict broadcast licences to broadcasters having both broadcasting facilities and programme production capabilities.

Part of the reason the government is so keen on digital terrestrial is that it is eager to stimulate the sluggish domestic economy by boosting demand for new broadcasting services. It

is also loath to fall behind the US and Europe in the race to the digital future, and anxious to avoid a repeat of the Hi-Vision debacle, caused by clinging too long to an outdated technology.

Part of the economic stimulation package is Y200 billion ($1.53 billion) in public funds for the digital terrestrial transition, including the construction of about 14,000 relay towers. Government officials justify the expenditure by pointing to estimates that the economic add-on effect of switching to digital — including consumer purchases of digital receivers — at Y38.6 trillion ($295 billion). In short, the MPT and its allies view digital as a vital key to the future of not only broadcasting, but the Japanese economy as a whole. – *Mark Schilling*

MALAYSIA

The country's sole direct-to-home satellite operator, Astro, has more than 170,000 subscribers. Astro, operated by Measat Broadcast Network Services, charges M$80 (US$22) per month, and offers 25 local and foreign services and eight radio channels. Hardware costs, which were slashed by half at the end of 1997, are M$999 (US$271) plus M$200 (US$54) installation. The platform has been running various special offers to drive up subscription. Currency fluctuations may drive hardware prices up to M$1,200 (US$325)-M$1,300 (US$352). Like IBC, Measat is also heavily subsidising the Philips digital boxes. The company is said to have set aside M$100,000 (US$27,000) until the end of 1998 to subsidise its price cuts. – *Janine Stein*

PHILIPPINES

Three digital DTH platforms are in various stages of preparation. The front-runner seems to be the Pacific Cable & DTU Systems, Inc, in which Malaysia's Measat Broadcast Network Services is involved. Two other platforms-in-waiting include the package being pulled together by H. Thomas Telesis Inc, which has just been granted orbital slot 151 degrees East by the Philippines government. The Telesis platform has pushed back its second-half 1998 launch to an unspecified date because of the region's economic problems.

A third package involves the Philippines Long Distance Telephone company (PLDT). South African-based MIH Asia, which has a substantial equity stake in Thailand's merged IBC-UTV digital/analogue pay-TV platform, is said to be angling for a piece of the PLDT project as part of its overall Asian expansion strategy. The PLDT platform is believed to be aiming for a third-quarter 1998 launch from the US$243-million Aguila-2 satellite.

Indications are that the Pacific Cable project, which will use Malaysia's Measat-2 satellite, is ready to go once it has sorted out set-top box prices, which have to be around US$300. As supplier to sister platform, MBNS' Astro in Malaysia, Philips is the natural choice to provide DTH hardware. However, other companies are being considered as well. Decisions about box subsidies have not yet been made.

The company claims to have completed the franchise and licensing process, and has begun testing the signals into the Philippines. Initial research has shown there is a market for digital DTH package priced at around Ps17,000 (US$446) – *Janine Stein*

SINGAPORE

Singapore may have banned direct-to-home satellite signal reception, but it has taken the digital terrestrial lead in Asia. Expectations are that the island state will launch Asia's first digital terrestrial service before the end of 1998 following a trial by the Singapore-based independent company, Advent Television Pte Ltd, earlier this year. Digital TV is forecast to be widely received in Singapore within three years. The Singapore Digital TV Committee is expected to recommend a digital TV standard by June.

Industry observers have noted that Singapore's emergence as a digital terrestrial leader over Hong Kong had nothing to do with financial advantages offered by Singapore authorities to attract broadcasters. "This has everything to do with the regulatory authorities in Singapore, who are far more in tune with the needs of the industry," one analyst said. "Singapore is much less bureaucratic. They understand the issues and can move quickly."

Singapore has another ace up its digital sleeve — the 86,000-square-feet Asia Broadcast Centre (ABC), which is home to broadcasters such as the Discovery Channel and Japan Entertainment Television (JET), and provides services to operators such as PanAmSat, CNBC Asia, the TV Shopping Network and The Filipino Channel. One of the largest facilities of its kind in the region, the ABC is a 50-50 joint venture between US-based Group W Network Services and the Singapore-based film and video producer, The Yellow River Network.

TAIWAN

Along with the Philippines, Taiwan is the next big thing on the digital satellite TV front. And again like the Philippines, Malaysia's Measat Broadcast Network Services (MBNS) has a hand in the platform which is the leading contender. MBNS, through XXX, has teamed up with Hong Kong terrestrial, Television Broadcasts Limited, which has set aside NT$1.64 billion (US$49 million) for the first three years of the Taiwanese venture. The formal joint venture agreement is expected by September 1998.

TVB's partners in the venture are ERA International Limited, which is connected to TVB; and Malaysia's MBNS Worldwide Sdn Bhd, the international arm of Measat Broadcast Network Services, which operates the Astro DTH platform. A company called All Asia Television and Radio Company (BVI) Limited will act for MBNS in the venture.

Although not finalised, the operation's initial paid-up share capital is expected to be NT$1.5 billion (US$45 million).

The TVB-Measat partnership appears to have a clear playing field with the collapse of Asia Broadcasting and Communications Network (ABCN). Management buyout efforts have so far been unsuccessful. – *Janine Stein*

THAILAND

Hard hit by the regional currency crisis, Thailand was the scene of one of digital TV's most brutal crashes when would-be mogul, Sondhi Limthongkul, was forced to sell his ABCN project to rival communications company Ucom soon after the Baht crashed in July 1997. As the economic crisis deepened, Ucom, battling to pay for the project's two satellites, pulled the plug on the platform. The demise of ABCN, the shut-down of Thai Sky TV's DTH package for non-payment of satellite transponder leases,and the merger of digital DTH platform, IBC, and cable network UTV in February have left the pay-TV market with one operator and a better chance than ever of making pay-TV pay in Thailand.

About 200,000 digital boxes have gone into Thailand. – *Janine Stein*

DVB Data Broadcasting:

Riding the digital wave

BY MARTIN JACKLIN

Earlier this year, the DVB Project released its long-awaited Data Broadcasting specification. This specification paves the way for high-speed transfer via satellite, cable and terrestrial digital TV channels. Applications include datacasting a-la teletext, downloading software, interactive TV and providing Internet services over broadcast channels. Here's what it all means for broadcasters.

DVB Systems provide a means of delivering MPEG-2 transport streams by a variety of transmission media containing MPEG-2 compressed video and audio. The use by DVB of MPEG-based data containers opens the way for anything that can be digitized to occupy these containers. For standard 6-, 7- or 8MHz channels, the DVB standard offers a data throughput potential of between 6- and 38Mb/s, depending on whether only a part of the channel or the full channel or transponder is used. Thus, the DVB Data Broadcasting standard will allow a variety of different, fully-interoperable data services to be implemented.

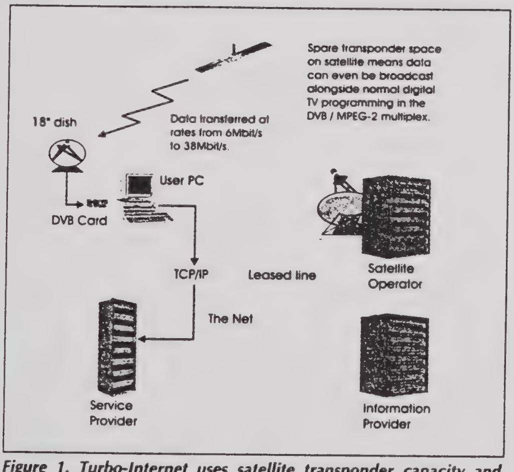


Figure 1. Turbo-Internet uses satellite transponder capacity and telephone network return channels to deliver high-speed data.

Data surfing via satellite

An obvious means of DVB data delivery is via satellite. DVB-S satellite transmission of data is faster than traditional telecommunications methods. For example, a file containing 10Mb of information normally takes almost 100 minutes to be downloaded over a typical telephone modem operating at 14.4kb/s. The same file, via satellite to a high-end server will take just 2.2 seconds to download at a bit rate of 38Mb/s. Downloading into a high-performance PC will take 14 seconds at a speed of 6Mb/s.

With a DVB receiver plug-in PC card, it is possible to use Internet services via satellite in an application recently dubbed *Turbo-Internet* (see Figure 1). Various European satellite operators, including Astra, Eutelsat and Hispasat, have implemented satellite DNBs. With more than 16 million PCs purchased in Europe in 1996 and more than 30 million households having direct access to satellite transmission, there is already wide acceptance of the datacasting technologies.

Datacasting or Internet services would typically use a broadcaster's extra satellite transponder capacity to broadcast material into the home. The data would then be directed to the consumer's PC via coaxial cable interfaced with a DVB-compliant plug-in card. Once decoded, information may be viewed on a browser or saved on the PC's hard disk for later use.

Where there is a need to have two-way communications, the user connects via the public network to a specific host computer or to a specific site on the World Wide Web. Conditional access components built into the PC card integrate with the subscriber management system, allowing the broadcaster to track and charge for the data that each subscriber receives.

The wide area coverage offered by a single satellite footprint ensures that millions of subscribers can receive data in seconds from one transmission. Since much of the infrastructure is already in place, very little additional investment is

needed from either broadcasters or subscribers. With possible bit rates of more than 30Mb/s per transponder, a typical CD-ROM could be transmitted to a whole continent in under three minutes. In the future, this capability will be possible over all the DVB delivery media, including cable and digital terrestrial, allowing the data to arrive along with normal TV services.

DVB data standards

The DVB Data Broadcasting Specification is based on MPEG-2 DSM-CC (Digital Storage Media Command and Control) and is designed to be used with the DVB-SI (Service Information) standard. Although the DSM-CC is a very complex (if not cumbersome) specification, it allows the choice of using only the relevant sections, and it is ideally suited to the problems of data broadcasting. The specification is designed to allow operators to download software over satellite, cable or terrestrial links, to deliver Internet services over broadcast channels and to provide interactive television — the broadcaster can choose appropriate services.

MHEG-5? What's that?

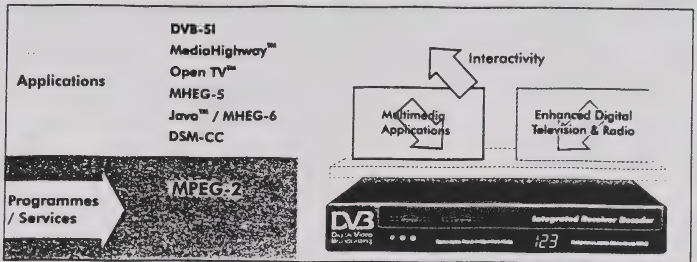
One of the important formats for enhanced broadcast services is the hypermedia language, MHEG for Multimedia Hypermedia Experts' Group. MHEG-1 (ISO/IEC 13522-5) specifies the coding of multimedia/hypermedia information objects for interchange as final form units within or across services and applications, by any means of interchange, including local area networks and wide area telecommunications or broadcast networks.

MHEG-5 (ISO/IEC 13522-5) defines the MHEG object classes for interchange and for use in base-level applications running on limited resource terminals, in interactive broadband services. It defines the coded representation for program objects in an open manner, so the program objects may encapsulate either standardized or proprietary program coding. MHEG-5 allows program objects to be included, as well as reference programs that may be encoded in any format. WBN

As the DVB project has progressed, interactive TV has been identified as one of the key functions of digital transmission. Many DVB members have developed comprehensive plans for the introduction of interactive TV and some are undergoing trials in Europe. Since the inception of the Digital Audio-Visual Council (DAViC), the central coordinating body for aspects of digital media convergence, DVB has understood its importance. The DVB Project recognizes the need for harmony with DAViC's work. DAViC liaison officers have been appointed by DVB to coordinate the efforts of both groups.

The result is a set of specifications for interactive services and a series of network-independent and network-specific specifications designed to suit the needs of the DVB members and the characteristics of the individual media that DAViC has identified. DVB Return Channel specifications have been published by ETSI. These include DVB-RCC (cable) and DVB-RCT (telephone and ISDN). These are complemented by the DVB-NIP (Network Independent Protocols), also published by ETSI.

DVB had produced specifications for interactive return channels based on Public Switched Telephone Networks (PSTN), Integrated Services Digital Networks (ISDN) and cable networks, including Hybrid Fibre Coaxial (HFC) Networks. The work is now concentrating on solutions for terrestrial systems, satellite master antenna television systems (SMATV), local multipoint microwave distribution systems (LMMDS) and digitally enhanced cordless telecommunications (DECT).



The DVB MHP (Multimedia Home Platform) will become a platform for generic Application Programming Interfaces (API).

Convergence work in progress

Recognizing the need to address the convergence of broadcasting, computer and consumer electronics in the home, DVB is examining the implications of the new digital transmission technologies. The Multimedia Home Platform group of the DVB Commercial Module was formed to identify the specific requirements for the digital set-top box, which is called the digital multimedia platform. Once these requirements have been identified, work will begin on a specification that will truly bridge the gap between TV-based and computer-based media.

The development of the Multimedia Home Platform (MHP) is probably the most important current new technology issue in the DVB Project. But what is the MHP? The group states that the MHP includes set-top boxes, integrated TV receivers, in-home digital networks, PCs and other computers. The goal is harmonization of the digital set-top box, which will be the core of multimedia in-home networks of the future. The concept of a multimedia home platform encompasses the local cluster of various devices and the network itself with broadcast and on-line services. There is already a wide range of return channel specifications available, and they are taken into account in the MHP work.

In the DVB environment, multimedia and hypermedia applications using broadcast and return channels would essentially consist of functions and calls, where the functions would be returned in an Application Programming Interface (API) language. DAViC defines API as "a boundary across which a software application uses facilities of programming languages to invoke software services. These facilities may include procedures of operations, shared data objects and resolution of identifiers." This definition, however, may be incomprehensible to the uninitiated owing to DAViC's wide scope.

Essentially, an application program interface is a built-in programmer's tool kit for requesting data objects or services resident on a particular operating system. Using the API, a programmer writing an application can make requests of the operating system. So, an API is an interface to an operating system.

Right now, the MHP is facing an API road block. A generic API would compromise existing proprietary systems developed by DVB members. One option could be for manufacturers to imbed a generic API into their proprietary systems in order to create the best market conditions.

The links need to be defined between

applications and the host platform, taking into account proprietary APIs, such as Sun/Thomson's Open TV and the Canal + Media Highway. At the top of the list of potential applications are "enhanced digital broadcasting," with or without an interactive return channel, and normal, on-line Internet access. Applications could include, for example, a content or event-oriented electronic program guide (EPG), using a browser-like graphical user interface.

Another key aspect is scalability, a feature of Java, which makes it possible to adapt to different high-end to low-end platforms. Joining various existing APIs to each other to achieve maximum commonality is a complicated process. On the commercial front, it requires the resolution of many thorny issues, which can only be done with full consensus. As a result, the debate in the DVB MHP module has been correspondingly intense. WBN

Note: Martin Jacklin is with the DVB Project Office, Geneva, Switzerland.

Where data broadcasting fits

Data broadcasting applications/profiles can be delivered generally in four ways (see illustration):

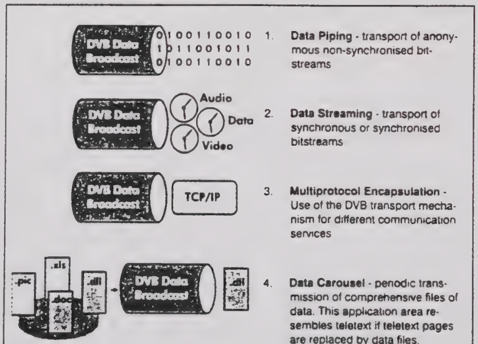
• *Data Piping*: This is the simple, asynchronous, end-to-end delivery of data through DVB-compliant broadcasting networks.

• *Data Streaming*: This supports data broadcast services that require a streaming-oriented, end-to-end delivery in either an asynchronous, synchronous or synchronized way through DVB-compliant networks.

• *Multiprotocol Encapsulation*: The data broadcast specification profile for multiprotocol encapsulation supports data broadcast services that require the transmission of datagrams of communication protocols via DVB-compliant broadcast networks.

• *Data Carousels*: The data broadcast specifications for data carousels supports data broadcast services that require the periodic transmission of data modules through DVB-compliant broadcast networks.

In addition to these four profiles, an object carousel specification has been added in order to support data broadcast services that require the broadcasting of objects as defined in the DVB's Network Independent Protocols specification. In order to cope with the existing proprietary data broadcasting solutions based on the DVB transmission standards that already exist, the DVB Data Broadcasting solution also includes a registration mechanism similar to that currently used for the registration of SI codes. In order to integrate the large number of existing data broadcasting applications currently in operation using the DVB transport standards, the DVB has established a mechanism whereby these systems can be registered. **WBN**



High Definition?

Can the currently sluggish progress be accelerated?
John Watkinson looks at some of the technical issues

The possibility of a new television standard raises a number of important questions. By its very nature a standard will have to endure for some time and if it isn't very good, the disappointment will be far reaching. Those who would create new standards have a great responsibility to ensure that they are as good as the state of technology allows, without being too expensive.

As any standard will be in widespread use, if it is poor value for money, there will be a widespread loss. Consequently the onus is on standards bodies to put forward systems which are efficient, particularly in terms of the ratio of picture quality to transmission bit rate. This is the only way forward, even if it means abandoning some traditional approaches.

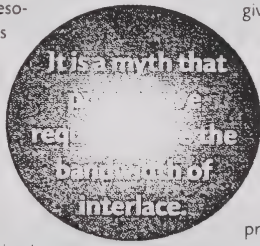
The raw bandwidth of analog high definition systems is such that they cannot be considered. The only way forward is to reduce that bandwidth. Analog bandwidth reduction and compression techniques have been used in the past, but their performance is complexity-limited, and often a loss of quality occurs.

The best emission-oriented compression mechanism we currently have is MPEG-2, which is digital. In the digital domain it is possible to perform extremely complex processes at low cost, and nothing else makes sense for a future format.

Figure 1 shows the existing analog bandwidth reduction techniques and their performance. At a) the conversion to color difference allows bandwidth reduction without noticeable loss. This is because color difference signals are a form of perceptive source coding that mimics the human visual system. This type of perceptive source coding is completely compatible with MPEG and should be retained.

In an analog system the bandwidth of the color difference signals can be reduced to one half. This halves the horizontal resolution without altering the vertical resolution, so the system is inefficient. In the digital domain it is easy to implement a vertical filter so that the color resolution is the same in vertical and horizontal directions.

For the same subjective result, RGB can be converted to color difference with no filtering, horizontal filtering or both horizontal and vertical filtering. This gives bit rate reductions of 100 per cent, 66 per cent and 50 per cent. Clearly the symmetrically-filtered system wins because the less raw data going into an MPEG coder the better it is going to be at handling the remainder. This is why the MP@ML MPEG uses 4:2:0 coding, because it's the most efficient. Anything which prevents the use of that efficient coding is suspect.



Composite video is shown in Figure 1b. The chroma signals modulate a subcarrier which is linearly added to the luminance using spectral interleaving so that only the luminance bandwidth is needed to transmit color. This is a genuine compression technique because there is a need for a decoder and the output bandwidth is higher than the channel bandwidth.

Composite is a lossy system because the spectral interleaving frequently breaks down so that the Y/C separation fails. The bandwidth of color difference signals is severely reduced, and various

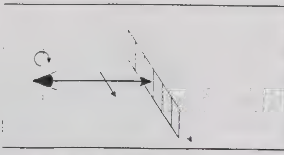
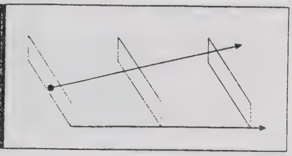


FIG 2
When the eyeball tracks, the image is stationary on the retina.

FIG 3A
Optic flow axis and time axis are non-parallel when there is motion.



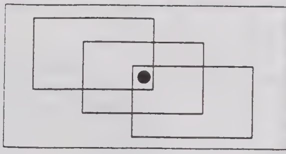


FIG 3B
Raster appears in different places with respect to a tracking eyeball.

FIG 1
The dominant non-MPEG compression techniques. Of these, only color difference filtering is useful for cost-effective high definition coding.

TECHNIQUE	CODING TYPE	MAJOR ARTIFACTS
a) Color difference	Perceptive pre-filtering	Benign – copies human visual system
b) Composite video	Analog compression technique	Y/C separation difficult, chroma bandwidth poor, false color on certain images
c) Interlace	Non-perceptive pre-filtering	Permanent loss of information, poor dynamic resolution, frame rate twitter on detail. Not appropriate for high definition
d) Anamorphism	Non-perceptive optical or non-square pixel sampling	Resolution worse in horizontal axis than vertical axis. Inefficient use of film and/or pixel data.

artifacts are added to the picture – including cross color and cross luminance, along with a pattern sensitivity which results in certain spatial details being misinterpreted as color.

The bandwidth reduction can easily be seen on color bars where the green/magenta transition – which is the worst case – always results in an artifact. The composite systems were the best that could be done with the technology of the day, but they are inappropriate in the MPEG domain. MPEG cannot handle composite video at all, and it's not very good with decoded composite either.

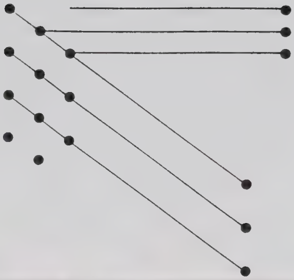


FIG 3C

With interlace, the dynamic resolution drops sharply when motion occurs. Resolution is halved when a vertical velocity of one raster line per field is obtained. The more lines in the raster the slower is the half resolution speed.

Figure 1c shows interlace. This is a lossy non-perceptive 2:1 filtering technique which saves bandwidth by confusing the vertical and temporal axes. This isn't strictly a compression technique because there's no decoder and the loss of bandwidth is permanent and can't be recovered. Unfortunately this results in serious loss of performance and the generation of artifacts.

Things go downhill fast if interlace is used with a lot of lines.

The loss of performance is roughly in proportion to the reduction in bandwidth, as you would expect from a filter. Interlace makes MPEG less efficient because there are no common pixels in adjacent pictures and motion compensation is harder. Also the viewer gets lots of artifacts added.

FIG 3D

With progressive scan, vertical axis and time axis are orthogonal. No loss of resolution occurs with motion. Dynamic resolution is 2X that of interlace. Hence it is a myth that progressive requires twice the bandwidth of interlace. For the same dynamic resolution it needs less bandwidth.

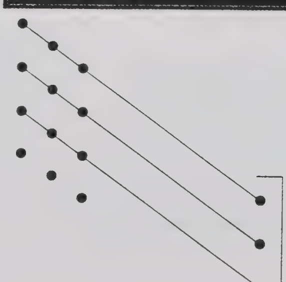


Figure 1d shows the use of anamorphic optics on a film or television camera, where the picture is horizontally squeezed during recording and expanded during playback. This is a lossy non-perceptive technique that has no merits whatsoever. As the resolution of film is axisymmetrical, the vertical resolution is in excess of the horizontal resolution. This is inefficient and sub-optimal as the input to an MPEG compression system.

Consequently, axisymmetrical lenses should be used for film, while video will require square pixels for identical vertical and horizontal resolution. In film, the aspect ratio of the film frame should be the same as that of the screen. In video, the number of horizontal pixels should be given by the number of vertical pixels multiplied by the aspect ratio.

The viewing experience is what matters, and it is crucial to setting a new standard that the human visual mechanism is well understood. At the moment it doesn't seem to be, hence there are a number of people running around saying progressive scan needs twice the bandwidth of interlace while this isn't born out of theory or practical demonstration. The only technique worth retaining from Figure 1 is color difference pre-filtering.

The viewer has an interactive visual system which allows the eyes to track the movement of any object of interest. Figure 2 shows that a moving object is rendered stationary with respect to the retina so that much the same acuity to detail is available despite motion. This is known as dynamic resolution and it's how humans judge the detail in real moving pictures. It astonishes me that video engineers so often state that softening of moving objects is acceptable, when it plainly isn't.

Figure 3a shows that when the moving eye tracks an object on the television screen, the viewer is watching with respect to the optic flow axis, not the time axis, and these are not parallel when there is motion. The optic flow axis is identified by motion compensated standards converters to reduce judder, and is also used by MPEG compressors because the most similarity from one picture to the next is along that axis. As these devices work well, there's nothing wrong with the theory.

Figure 3b shows that when the eye is tracking, successive television pictures appear in different places with respect to the retina. In other words, if an object is moving down the screen and followed by the eye, the raster is actually moving up with respect to the retina.

This has some interesting consequences. Figure 3c shows what happens with interlaced scanning. When there is no motion, the optic flow axis and the time axis are parallel and the apparent vertical sampling rate is the number of lines in a frame. However, when there is vertical motion, the optic flow axis turns. In the case shown, the sampling structure due to interlace results in the apparent vertical sampling rate falling to one half of its stationary value.

Consequently, interlace does exactly what would be expected from a half-bandwidth filter. It halves the resolution when anything moves. Figure 3d shows that in a progressive scan system this doesn't happen – the dynamic resolution is the same as the static case.

It is easy to calculate the vertical image motion velocity needed to obtain the half-bandwidth speed of interlace, because it amounts to one raster line per field. In 525/60 there are about 500 active lines, so motion as slow as one picture height in 8 seconds will halve the dynamic resolution. In 625/50 there are about 600 lines, so the speed falls to one picture height in 12 seconds. This is why NTSC doesn't look as bad as it should compared to PAL, because its dynamic resolution at low speeds can be higher.

Things go downhill fast if an attempt is made to use interlace in systems with a lot of lines. In 1250/50, the resolution is halved at a vertical speed of just one picture height in 24 seconds. In other words, on real moving video a 1250/50 interlaced system has the same dynamic resolution as a 625/50 progressive system.

In high line-number systems, interlace softening kicks in at a lower speed, and it's clear to the naked eye when this happens. I don't regard interlaced systems as high definition. Their theoretical, subjective and economic performance doesn't warrant their inclusion in future systems. The large number of lines simply allows the viewer to see the loss of resolution on motion more clearly.

Interlace was the best that could be managed with thermionic valve technology sixty years ago. Leave it there. ■

What's a Mole Have to Do With MPEG?

by Randy Hoffner

With the arrival of digital video and audio compression as regular features of our broadcasting lives, we seem to be simultaneously taking great leaps forward and great leaps backward. Digital compression is the breakthrough technology without which we could not contemplate digital broadcasting.

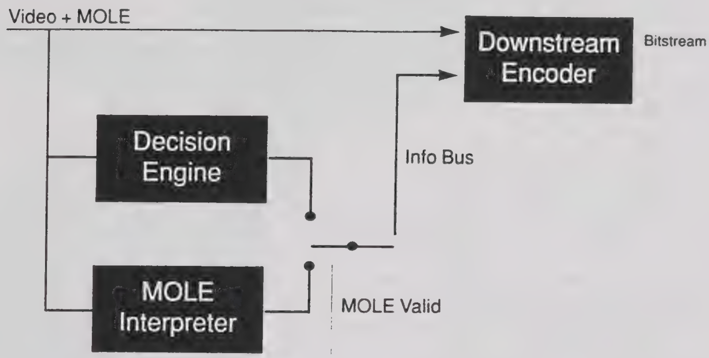
It is also so new and so different from the way that we do television today, that in many respects it seems that we have returned to 1950! Many of the audio and video processing operations that we routinely perform today present a whole new set of challenges when we operate in the compressed domain.

Digital video is a wonderful thing, but it has one big problem: The digitization of motion video generates a prodigious quantity of digital data. This is true of standard-definition video, but it is an order of magnitude truer of high-definition video.

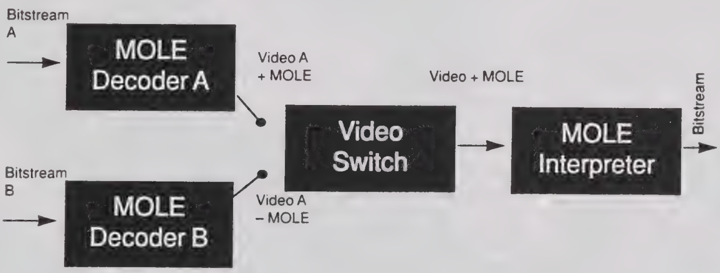
ITU Rec. 601 video generates a payload data rate of about 150 Mbps, while 10-bit HD video's payload data rate is about 1.5 Gbps. In order to broadcast or otherwise transmit (on a satellite transponder, for example) this quantity of data, bit-rate reduction is an absolute necessity.

It is not feasible at this juncture to carry out processing operations on video (or audio) when it is compressed into MPEG bitstreams. Rather, the bitstreams must be decompressed to their full bit-rate "baseband" in order to do most processing operations. This necessarily implies the requirement for multiple decoding and re-encoding cycles to be performed on the compressed bitstreams, and the potential for degradation of the quality of the images.

MOLE Encoder



Stream Switcher with MOLE



JOINT EFFORT

The BBC and Snell and Wilcox, in a joint effort called the ATLANTIC project, have been studying cascaded compression cycles, and have come up with some interesting results. As an MPEG encoder compresses video, it has to make a number of "decisions" about how to code the pictures. These decisions include such things as picture type, i.e., I-frame, P-frame or B-frame; prediction mode, i.e., forward prediction, backward prediction or bi-directional prediction; generation of motion vectors; and coarseness of quantization. There is usually no guarantee that the coding decisions made on the first compression will be duplicated upon the second and subsequent compressions, and this causes a buildup of coding artifacts during cascaded compression cycles.

The ATLANTIC project is based on the premise that if the coding decisions made by the first encoder are preserved and re-applied when subsequent compressions are performed, the buildup of artifacts is significantly reduced. It is claimed that this makes the process of cascaded decompressions and recompressions effectively transparent.

The BBC Web site (www.bbc.co.uk) cites an example in which, for cascaded MPEG coding at 4 Mbps, the PSNR of the pictures degrades more than 5 dB over eight generations of coding/decoding when coding decisions are lost, vs. nearly no degradation in PSNR over eight generations when coding decisions are preserved. It must be said that those involved in the analysis of the subjective effects of video compression will quickly point out that a PSNR number is not necessarily a precise indicator of perceived picture quality, which is quite dependent on what the noise in a picture looks like – not simply on its magnitude.

The number is useful as a trend indicator, however. One more qualifier must be inserted here. All

Digging MPEG?

the work done in the ATLANTIC project was done on standard-definition video. The technology is applicable to all MPEG-2 coded video, however – SD or HD.

MOLE METHOD

The Mole is a method whereby the preserved coding decisions are invisibly embedded in a Rec. 601 video signal, allowing them to "burrow through" conventional 601 processing and switching equipment, making them available for use in subsequent MPEG re-encoding.

The process requires special decoders and encoders. The simplest implementation is the back-to-back hookup of a decoder and an encoder, with no intervening processing. An ATLANTIC decoder extracts the "side information" (motion vectors, coding decisions) from the MPEG video, and organizes them into a data structure called the "information bus."

The ATLANTIC decoder then has two outputs, video and the information bus. The video is re-encoded with an ATLANTIC "dim coder," an MPEG encoder that takes most of its coding decisions from the information bus, instead of thinking for itself.

It may be shown mathematically that for this back-to-back configuration the only cascading impairments introduced by the decoding/re-encoding process are those due to mismatches between the DCT and inverse DCT functions, which may be shown to be negligible.

Two processes that may make use of the information bus as described above are picture processing and transcoding, in which no picture processing takes place, but re-encoding is performed with some change in parameters – for example, a change in bit-rate.

The bitstream switch exemplifies a simple processing operation. I have in the past described the problems associated with MPEG bitstream switching, i.e., frames of unequal duration, the timing of decoder buffer emptying and filling, and the requirement for the generation of "splice markers" – points at which the bitstream is constrained in such a way that all the frame duration and buffer management requirements are met so that a seamless transition between MPEG bitstreams can be attained.

The ATLANTIC approach to bitstream switching actually performs the switch in the video domain. It requires a decoder for each source bitstream, and the insertion of a video switch and an information bus processor between the decoders and the dim coder used to recompress the video streams.

The technology may certainly be applied to high-definition MPEG.

In the steady-state condition, the selected video and information bus signals (Bitstream A, for example) pass unchanged through the video switch and information bus processor to the dim coder, effectively resulting in a simple cascade. When a switch is made to Bitstream B, after the switching operation a steady-state condition obtains, and Bitstream B passes unchanged through the video switch and information bus processor.

The switching operation itself is carried out on the decoded video signals. There is now no problem with frames of different lengths, buffer timing, etc. Of course, the video signals must be synchronized, and this may be done either in the bitstream domain by introducing the requisite delay in the decoder buffers, or in the video domain using the conventional synchronization techniques that we are quite familiar with.

Near the switching point, neither Information Bus A nor Information Bus B may be used directly as the source of re-encoding decisions, because these decisions look either forward or backward in time, causing the re-encoder to refer to picture information on the wrong side of the switch point – i.e., the coding decisions from Bitstream A would be applied to the sequence of pictures from Bitstream B, and vice versa.

During this brief switching period, the dim coder has to be a little brighter, as it must make coding decisions on its own, as a typical MPEG encoder would do upon a scene change. To minimize this disturbance at the switching point, the re-encoder must lock to the new bitstream's information bus as quickly as possible.

In principle, the simple video switch may be replaced by a production switcher, a DVE, or any other type of video processing equipment. The information bus signals would of course have to be carried along, and passed around the video processing stages and processed separately.

This is done in the ATLANTIC project by converting the information bus signals into a format called the Mole, which is embedded in the uncompressed bitstream. Whenever the processing equipment is passing an input signal through untouched, the Mole associated with that signal "burrows" through the studio equipment, emerging at the output to be used for re-encoding.

When the processing equipment is affecting the video signal in any way, the Mole signal is automatically destroyed so that it cannot be used for re-encoding. The ATLANTIC decoder has a "Mole composer" that creates the Mole signal and inserts it into the video signal, while the dim coder has a "Mole interpreter" that decodes the Mole signal and uses it to recompress the video signal.

There are three principal requirements to make all this work. The Mole signal must be invisible on the video signal, all studio equipment must be capable of passing the entire digital signal untouched, and the decoder must be capable of detecting when the Mole is not valid.

No special constraints are imposed on the bitstream, and there is no requirement for splice markers. It is true that as the coding decisions of the first encoder are carried through to the final encoding process, the quality of the first encoder in the chain should be as high as possible.

When transcoding to a different bit-rate, no pixel processing is done, so the Mole signal is [illegible] required – only the information bus between decoder and re-encoder. The simplest transcoding method is the so-called "drifty transcoder," in which the bitstream is decoded only to the point at which inverse-quantized DCT coefficients are generated.

The coefficients are then requantized at the new bit-rate using the coding decisions supplied by the information bus. This is called a "drifty" transcoder because the predictions generated in the decoder will not match those generated in the encoder, causing errors to be accumulated in successive P-frames. This transcoder has the advantage [illegible] being very simple. The so-called "full transcoder" implements interconnected prediction loops in both encoder and decoder.

The ATLANTIC technology described is a work in progress, and not a finished body of knowledge. As previously mentioned, the work is being done on standard-definition MPEG signals. The technology may certainly be applied to high-definition MPEG signals, of course. The closer we come to actually implementing DTV and making MPEG a part of our daily lives, the more we realize how much work remains to be done in order to fully exploit this cutting-edge technology. ■

The ultimate

The increasing sophistication of set-top boxes is
television set. Ch

Barely a day goes by without some new television-based technological leap being promised by this or that news story. And, more often than not, the stories are just as likely to be on the business pages of our leading newspapers, as in the technology section. Moreover, it also seems that the humble set-top box (STB) receives its fair share of such headlines.

In February of this year, seven of North America's largest cable operators agreed that this July they will join Comcast Corp and Time Warner Cable in deploying the 'Explorer 2000' two-way, Internet-capable, digital set-top boxes developed by Scientific-Atlanta Inc (S-A) which are also made by S-A along with its arch-rival, General Instrument (Jerrold). The deals appear to underscore the cable operators' insistence that no one supplier will dominate broadband, digital, interactive TV.

set-top box?

ıling a range of interactive applications - including Internet access - to be delivered directly to the ɔrrester reports on the latest advances in set-top box technology.

Chris Majara, S-A's European Marketing Manager, believes that these boxes, especially with their Internet connectivity, will lead the way to "opening up many new applications from videoconferencing and tele-medicine to education, wherever you want to combine TV with text and graphics and interactivity". Majara estimated the number of developers building Web material at more than 400,000.

The American-specified box features digital video decoding, a downloadable PowerTV operating system, a high-speed Internet protocol channel, Ethernet output, HyperText Markup Language (HTML) and JavaScript interfaces, and a Sun Microsystems 'MicroSparc' processor. As a result of the deal - and the rapid shift away from analogue decoder boxes - Scientific-Atlanta announced it would be discontinuing making analogue decoder boxes.

But this commitment has other implications. It will lead to several million boxes being ordered with Sun's Java HTML language incorporated. That may not please Microsoft boss Bill Gates, who is known to be talking to John Malone, long-time leader of America's cable industry, and head of America's largest cable company TeleCommunications Inc (TCI).

According to reports Bill Gates wants TCI and the other uncommitted cable (and satellite) companies to delay ordering decoders until he can deliver a set-top box with his cut-down Windows CE technology built-in.

To help focus their minds Ed Huguez, DirecTV's Vice President of new media and interactivity, has said that DirecTV will provide Microsoft with its development plans so that its next generation of satellite boxes can be compatible with Windows '98.

Huguez also said he may offer a set-top box in 1999 to provide Internet access via its digital satellite system. The partnership between the companies began in March 1996, but DirecTV wanted to launch its product as soon as possible, whereas Microsoft wanted to time the product closer to the introduction of Windows 98, claimed Huguez.

Interactive services via analogue TV

Meanwhile, in Germany, electronics giant Siemens Nixdorf has announced its MultiMedia Integration Box, the first in a new generation of home PC/TV systems which, it says, closes the gap between the worlds of entertainment and information technology. For the first time, the new MultiMedia Integration Box combines a standard analogue TV set with industry-standard NetPC technology to allow all interactive and digital services from the entertainment, communication and on-line services markets to be received, retrieved and viewed on a conventional television set.

Whether the 'digital' home is seeking this analogue solution is a matter of debate. But with this product, Siemens Nixdorf is focusing on service providers, hotels and large companies who want to offer additional services to their customers. The new MultiMedia Integration Box is positioned to support both analogue and digital TV, with NetPC functionality enabling Internet and web access. It also supports a wide range of additional applications, including electronic commerce, near video on demand, standard and video telephony, videoconferencing, interactive games, telefax, e-mail and multimedia mail, digital TV encoding, radio, business TV, audio, video and pay-TV.

"Siemens Nixdorf believes that today's set-top boxes are too narrow in concept, and we've introduced our new MultiMedia Integration Box based on NetPC technology to provide consumers with as much functionality as possible," explained Dr Peter Page, Siemens Nixdorf Informationssysteme AG's Chief Technology Officer. "We believe that 1998 will be the year when Web TV really takes off, and we're currently field testing the product and working with partners to develop new applications and services. We're just as serious as Microsoft about Web TV, and we're all now looking for the killer application that will help us to reach our aggressive sales target of some one million units."

A key feature of Siemens Nixdorf's new MultiMedia Integration Box is the facility to manage the system on-line using standard Zero Administration techniques. Consumers will have access to on-line help, and will be able to use their telephone lines to talk directly to a specialist helpdesk where trained consultants can effectively take control of the user's system while discussing and resolving the user's problem. According to Peter Page, "this facility marks a totally new era of network-based service, and shows Siemens Nixdorf making the home PC a true network-based device".

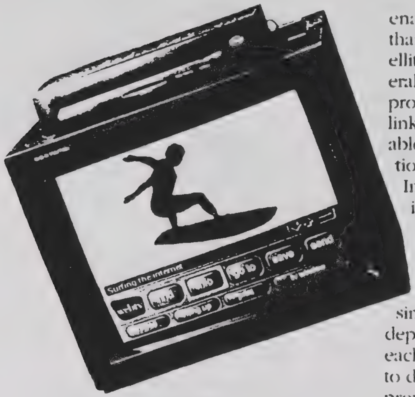
The MultiMedia Integration Box converts digital signals into analogue signals that can be processed by a conventional television set. Key components of this standard PC technology-based box include:

- special interface for connection to the TV set;
- a chipcard reader for access control;
- online Zero Administration management;
- an infrared device that functions like a mouse for making entries;
- 'Web-Facer' user interface for increased ease-of-use

PCs as TVs, or TVs that act as PCs?

The debate as to whether we want our TV sets to double as personal computers, or the other way around, will rage long and hard during 1998 and 1999, by which time most experts expect a common standard beginning to emerge.

That's certainly the view of Pace Micro Technology, who have already supplied well over 1.25 million digital decoders, and are working on 'next generation' STBs for many Far East clients as well as influential leading-edge broadcasters like Canal Plus and BSkyB. Nick Gregory, Pace's Head of Product Marketing: "Our next generation of boxes reflect what broadcasters are wanting to do, embracing services that are available through the Internet and the interactive



services we can offer such as home banking, home shopping, telebanking, games, services via the set-top box. So we're talking about those services in terms of expanding the functionality of the box."

Pace, and other digital STB manufacturers, are already building in the functionality that allows direct buying of items broadcast on home shopping-type channels. Some digital broadcasters are already flashing on screen an icon (usually of the remote control) indicating that viewers can now 'select' an item provided the STB is hooked into the telephone system. Gregory: "You could have conditional access, provided some form of an active memory existed, to allow the person to have so much money available, so he could only spend up to a certain amount. He pays through his normal subscription service but you use the conditional access system to allow a certain amount of "money" in the box.

The Ka-band factor

Currently the key for such 'return-path' technology is the telephone (or cable-enabled) link. That's about to change thanks to the availability of Ka-Band satellite uplinks. Pace's Colin Smith (General Manager, Engineering): "Ka-Band will provide similar services [as the phone-link]. It's a question really of what available bandwidths you have in both directions. Clearly, with a function such as Impulse PPV, the actual information going back is relatively small, so a telephone link is fine. If you wanted to do something like Internet, there is obviously quite a significant two-way interchange of information and similarly with the Ka-Band, it all rather depends on what bandwidth they allow each individual to have in each direction, to determine which is the best service to provide."

While many industry experts suggest that Ka-Band uplinks will only ever be allowed for small business-type users, even within this sector there could be problems, especially as everyone saves their data-transfers to the end of the local business day (say 1700-1900 hours), which could place the severest strain on satellite Ka-Band capacity. Pace's Smith: "You can already come up with methods which use the bandwidth given that the capacity is going to be there, but one of the problems in the satellite environment is that if everyone wants that bandwidth at the same time, it may appear limitless but gets used up very quickly. I think there are possibilities there, but it's really a question of what the cost of the bandwidth is at the end of the day."

Nick Gregory adds: "There are a lot of problems dealing with frequencies of that level and people are just starting to address them. The commercial application is something, I would guess, which will develop over the next two or three years."

As well as preparing for Ka-Band use, Pace's technology team are working on developments that include a variety of applications. Gregory again: "There'll certainly be information technology, telephony, video telephony, and things like interactive games for people playing in different locations. What you've actually got is a sort of bringing together of television and telecommunications infrastructure. Clearly, the possibilities of interactivity of different people for games would be much enhanced. This could mean the PC-top camera, the set-top camera, could be utilised within a box, with the right architecture and the right price performance, you could certainly do something of that nature. It's technically feasible now but it's a question of how much people would pay for it. We're looking closely at the amount of built-in memory within the box, which is already fairly substantial and enough to run fairly advanced operating systems, supporting all of the higher level functionality through things like Internet browsing and the like. Typically, we're seeing the memory of the boxes double and in some case, increase beyond that."

Gregory also enthuses about the potential of Web TV: "We're a licensee of Web TV technology and they are at the forefront of developing this enhanced TV experience and the link between the Internet and broadcast TV. What we are seeing is a very, very powerful demonstration of how you can put these two currently separate activities together and we think it will be very, very beneficial for the consumer. It will enhance the experience quite considerably. If you want to take, typically, the [Super Bowl] football game from North America where there were lots of breaks, and if you think during those breaks you can 'surf' the Internet about particular players or look at statistics on the game etc., it really does start to have considerable benefits for the consumer. There is no doubt that there are people out there interested in developing both the storage capabilities of the box and, for instance, the Web TV platform launched in the last year in North America has in-built a 1.1Gbit/s hard drive, so they can cache data on the disk and you can actually 'surf' the Internet without actually being on-line.

"The next stage of development will be to download that data off the off-air signal so it will come in as you are receiving the broadcast TV information. So your own dedicated Web pages with highlighted information specific to you would be there waiting for you when you turn the TV on, so that you could 'surf' into the Internet from the broadcast TV without actually going on-line. We have looked at giving viewers their own choice of electronic programme guide, but no broadcaster is currently seeking to develop that, the reason being that the EPG is considered very much a branding to broadcasters, and it is their identity and their route to how people navigate

Service	When available
100+ channels of PPV	Now, via digital satellite
Multi-camera choices	Now, via digital satellite
Electronic Programme Guide	Now, via satellite and cable
Web-browsing	Now, via PC/Web TV/some satellite
E-Mail	Now, via PC/Web TV/some satellite
Online banking	Now, via PC or telephone with some banks
Online financial services	Now, via PC/Web
Online chat	Now, via PC/Web
Online gambling	Now, via PC/satellite+telephone
Interactive advertising	Now, via PC/Web
Multi-Player gaming	Now, via PC and some cable systems
On-demand porn	Now, via PC/Web
Home video telephony	Now (at low bit rate), via PC
Telephone-service	Now, via telco or some cable/cellular companies
On-demand audio	Now, via PC/Web
Word-processing	Now, via PC
Home accounts software	Now, via PC

TABLE 1: The supreme decoder box

through the services. Obviously, if they start handing over the ownership of the EPG to the consumer, they start losing some of the control they can exercise."

Satellite or Web?

Pace are licensees of Web TV, the service that Bill Gates (why does that name keep cropping up?) bought last year for a staggering US$425 million. However, one leading American research group predicts that as far as the American market goes, the demand for such levels of 'interactivity' is currently limited, perhaps to only 100,000 users per annum (in the US). But the research suggests that demand in North America (and in other developed countries) will accelerate rapidly from around the Year 2000 onwards. In North America, the research states, it could explode to around 14.7 million homes by 2002 "equipped with Internet-enabled TVs". Note the description, "Internet-enabled TVs" specifically not TV-compatible PC's. The research is correct, human beings are not equipped to sit for pleasure in front of a PC, especially not on a hard, upright chair.

If the projections are right - and give or take a million, I suspect they are - almost everyone who today has a simple television will have switched to digital and moreover be 'viewing' the Internet via the TV set, and the comfort of an easy chair or sofa. This leads to opportunities and a few considerable threats to broadcasters.

Currently channels are 'controlled' by the platform-owner, who acts as gatekeeper for the bouquet of services available. That gatekeeping role will continue even if the raft of services extends to limited interactivity (of the satellite-delivered DirecPC type) or the 'walled garden' approach being adopted by many digital satellite broadcasters, where viewers can roam at will within about 100 or so sites within the garden, but cannot 'escape' over the garden-wall to the world outside.

The PC-user knows no such limitations, being free to roam at will with only the on-line time (at a local rate) to limit their use. However, with higher bandwidths being embraced, greater set-top memory being built-in and the sort of functionality all of the leading manufacturers are promising, also risks dissatisfying the TV-surfer if true Internet-access is denied them. For within those Web-based choices comes thousands of (currently) near-TV quality channels, that are frequently created by amateurs and enthusiasts, people who have completely by-passed the normal route into broadcasting. Web-streaming technology (from the likes of Progressive Networks' Real Video Real Audio) will inevitably lead to greater use of these Web-based channels.

Second, or 'next generation' decoder boxes open up a wonderful world of opportunities, but the risk that viewers will tune away from the conventional networks (however delivered) and instead watch Internet-based material is considerable. The established broadcasting networks could see their viewers tempted away by a new breed of 'narrow-casters'.

SPACE PACIFIC Digital Satellite TV Installer Certification Course

For anyone who may not currently have a solid technical background but has the desire to learn about digital TVRO technology and is ready to absorb the basics required, one step at a time and at a pace that fits their personal needs.

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☐ **Digital video compression:** *from analogue to digital, bit rates, MPEG, DVB forward error correction, symbols, coding, bit error rate, and digital IRD threshold.*

☐ **Feedhorns and LNBs:** *the impact of thermal noise; LNB gain, noise temperature, stability & noise figure; feedhorn design and use, polarisation methods, hybrid feeds, and multi-feed systems.*

☐ **Satellite TV Antennas:** *prime focus, offset, and planar array antennas; antenna gain, G/T, side lobe performance, beamwidth, and calculating system C/N performance.*

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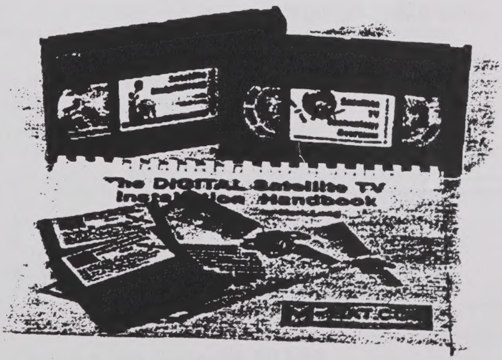

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☐ Satellite controlling earth stations and broadcasting centres.

☐ TV receive-only satellite system component design and application.

☐ Satellite TV link budgets.

☐ Non-video receive-only applications, including Internet service access.

☐ DTH & SMATV installations, including downlink site surveys, installation requirements and system troubleshooting techniques.

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Fax: 64-9-406-1083

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The purpose of this Database survey is to allow SPACE to supply your firm's name and capabilities to satellite system network developers who are routinely contacting SPACE for qualified personnel and businesses to do C and or Ku band system installations under contract. All membership levels **except** "Individual Member" are requested to complete this survey form and return it to SPACE Pacific Ltd., PO Box 30. Mangonui. Far North. New Zealand (fax 64-9-406-0183).

NAME of your firm ______________________________
MAILING address ______________________________
TOWN/City ____________________ Region/State ___________ Country________

NAME of contact person ______________________________
WORK telephone ____________________ After hours telephone ______________
WORK fax ______________________ email ______________________

Experience in Installing -

C-band TVRO up to _____ metres in size
Ku-band TVRO up to ______ metres in size
MDU (multiple dwelling unit) installations using (check highest applicable)
___40-230 MHz. ___40-500 MHz. ___ 40-890 MHz. ___ 40-1450 MHz. ___ 40-2.150 MHz of up to ____ (number) outlets

Complete as applicable (yes or no) -

___ Az-El motor driven systems. ___ Polar Mount motor driven systems.
___ ortho-mode feed systems. ___ dual-band feed systems.
___ MPEG-2 or other digital TVRO systems.
___Data (such as Internet) digital receive systems.
___ Two or more dishes - same site, systems
___ Roof top, other non-ground mount antenna systems
___ Offset fed antenna systems. ___ Prime focus antenna systems

Commercial Installation Experience with - (as applicable - check off)

___PAS-4 68.8E. ___ Ap2R 76E. ___ Th3 78.5E. ___S14 96.5E. ___As2 100.5E.
___ S21 103 E. ___ C2 113E. ___ JcSAT 3 128E. ___ Ap1A 134E. ___ Ap1 138E.
___ Me2 148E. ___ C1 150E. ___ B3 156E. ___ B1 160E. ___ Pas-2 C-band 169E.
___ Pas-2 Ku band 169E. ___ I174 174E. ___ I177 177E. ___ I180 180E

Test and Other Equipment-

___Spectrum analyser (make. model) ______________________________
___ Other as applicable to TVRO ______________________________

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